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New England Water Works ASSOCIATION.

1890-91.

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NEW ENGLAND WATER WORKS ASSOCIATION.

ORGANIZED 1882.

Vol. V. June, 1891. No. 4.

This Association, as a Body, is not responsible for statements or opinions of any of its members.

MARCH MEETING.

YOUNG'S HOTEL, BOSTON, March 11, 1891.

The regular quarterly meeting of the Association was holden here to-day. In the absence of President Noyes, Treasurer Nevons presided, and the following-named gentlemen were present: —

ACTIVE MEMBERS.

Solon M. Allis, Malden, Mass.
Phinehas Ball, Worcester, Mass.
Lewis M. Bancroft, Reading, Mass.
Albert P. Barrett, Woburn, Mass.
Jos. E. Beals, Middleboro', Mass.
Nathan B. Bickford, Boston, Mass.
Wm. R. Billings, Taunton, Mass.
Dexter Brackett, Boston, Mass.
A. W. F. Brown, Fitchburg, Mass.
Geo. F. Chace, Taunton, Mass.
H. W. Conant, Gardiner, Mass.
R. C. P. Coggeshall, New Bedford, Mass.
Byron I. Cook, Woonsocket, R.I.
P. F. Crilly, Woburn, Mass.
Lucas Cushing, Boston, Mass.
Edwin Darling, Pawtucket, R.I.
F. W. Dean, Boston, Mass.
A. B. Drake, New Bedford, Mass.
T. M. Drown, Boston, Mass.
J. W. Ellis, Woonsocket, R.I.
H. L. Eaton, Somerville, Mass.
F. F. Forbes, Brookline, Mass.
F. L. Fuller, Boston, Mass.
A. S. Glover, Boston, Mass.
W. J. Goldthwait, Marblehead, Mass.
John A. Gould, Boston, Mass.
E. H. Gowing, Boston, Mass.

Walter Hale, Orange, Mass.
F. E. Hall, Quincy, Mass.
E. A. W. Hammatt, Boston, Mass.
J. C. Hammond, Jr., Rockville, Conn.
J. L. Harrington, Cambridge, Mass.
John Harris, Waltham, Mass.
John C. Haskell, Lynn, Mass.
W. M. Hawes, Fall River, Mass.
R. S. Hicks, Stafford Springs, Mass.
H. N. Hyde, Jr., Newtonville, Mass.
A. A. Jenkins, Milford, Mass.
Willard Kent, Woonsocket, R.I.
T. C. Lovell, Fitchburg, Mass.
William McNally, Marlboro', Mass.
J. W. Morse, Natick, Mass.
Hiram Nevons, Cambridge, Mass.
E. H. Phipps, New Haven, Conn.
Geo. J. Ries, Weymouth Centre, Mass.
H. W. Rogers, Salem, Mass.
A. H. Salisbury, Lawrence, Mass.
J. D. Shippee, Holliston, Mass.
G. A. Stacey, Marlboro', Mass.
F. P. Stearns, Boston, Mass.
M. M. Tidd, Boston, Mass.
Chas. K. Walker, Manchester, N.H.
J. C. Whitney, West Newton, Mass.
H. B. Winship, Norwich, Conn.
G. E. Winslow, Waltham, Mass.
E. T. Wiswall, West Newton, Mass.
M. F. Wright, Lowell, Mass.

ASSOCIATE MEMBERS.

J. M. Betton, Boston, Mass.
A. H. Brodrick, Chadwick Lead Works, Boston, Mass.
E. L. Ross, Chapman Valve Manufacturing Co., Indian Orchard, Mass.
T. M. Hayes, Dean Steam Pump Co., Holyoke, Mass.
Gilchrist & Taylor, Boston, Mass.
J. A. Tilden & E. D. Winton, Hersey Manufacturing Co., Boston, Mass.
F. E. Stevens, Peet Valve Co., Boston, Mass.
E. L. Abbott, Thomson Meter Co., New York City.
Jesse Garrett, R. D. Wood & Co., Philadelphia, Penn.
A. D. Blossom, Whittier Machine Co., Boston, Mass.
W. S. White, Boston, Mass.

GUESTS.

Hiram F. Mills, C.E., Lawrence, Mass.
H. H. Johnson, Chairman Water-Supply Com., Mass. Legislature.
E. B. Parkhursh, Woburn, Mass.

A. L. Forbes, Holliston, Mass.
J. J. Moore.
D. J. White.
Chas. E. Ryder.
C. W. Shattuck, Norwood, Mass.
F. M. Ashley, New Bedford, Mass.
A. D. Nickerson, Pawtucket, R.I.

Lunch being finished, Chairman Nevons rapped the meeting to order and spoke as follows: —

The CHAIRMAN. — I was informed that the President of the Association was unavoidably absent in New York, and that it was my duty to preside; and I never like to shirk my duty. But when I consented to preside to-day I did not know that the Vice-President of the Association was here. Now Mr. Walker owes you an apology, and if you do not compel him to make it before we get through it will be no fault of mine. I also wish to state that Dr. Walcott is unavoidably absent on account of sickness in his family; but he has sent a good substitute here, Mr. Mills from Lawrence, who will speak later on. I have another bit of an apology to make, and that is — our old friend Munroe is sick and cannot be here to-day; but Mr. Danforth has kindly consented to come and assist Mr. Pratt, and I have no doubt we shall be well satisfied. They will now give us a song.

A song was then given by Messrs. Pratt and Danforth.

The CHAIRMAN. — Gentlemen, I take great pleasure in introducing to you Mr. H. F. Mills, of the State Board of Health, who will speak to you on the relation of water-supply to typhoid fever, almost the identical subject that was announced to be spoken on by Dr. Walcott. (Applause.)

Mr. Mills having read his paper and its discussion having been finished, the Secretary read the application for resident active membership in the Association of George H. Nye, Civil Engineer, New Bedford, Mass. The Secretary was instructed to cast the vote of the Association in favor of the admission of the applicant, and this having been done, Mr. Nye was declared by the chairman duly elected to membership in the Association.

The CHAIRMAN. — I have the following communication from the Secretary of the American Water Works Association: —

AMERICAN WATER WORKS ASSOCIATION,
OFFICE OF SECRETARY & TREASURER, ELMIRA, N.Y., March 9, 1891.

R. C. P. COGGESHALL, *Secretary New England Water Works Association:* —

DEAR SIR, — I very much regret that I am unable to meet with you this time, but am too busy preparing for the next meeting of the American Water Works Association next month.

We shall be very comfortably quartered at the "Continental," where there will be room for everybody; and we cordially invite all or any members of the New England Water Works Association to meet with us. We can insure you a very pleasant, and we think profitable, time. Our programme will embrace some very interesting topics treated by able writers, and the Philadelphians will certainly look well to our comfort and enjoyment.

Trusting that you will have a very pleasant meeting and enjoy it so much you will all want to come to Philadelphia,

I am, yours truly,

J. M. DIVEN, *Secretary.*

The CHAIRMAN. — There is no special action to be taken on this letter, but I do not think there is any doubt that every member who attends that meeting will have a good time. Is there any other business to bring before the Association at this time?

Mr. BILLINGS. — I have a little matter of business that I am going to venture to offer on my own responsibility. It remains to be seen what the Association may think of it. This Association has been growing for some years. The meetings during this past winter are sufficient evidence of that. The interest has been increasing. And I do not know of an association which has reached the dignity and importance that this Association has now attained which is quite as indifferent — I may say "happy-go-lucky" — in its method of selecting its officers. And if we were to judge by the result obtained in the past, the "happy-go-lucky" method has been a good one, because no one can find any fault in that direction. But while we are so prosperous and while we are in such excellent shape, the question has come to me whether it will not be well to remember that with this growth and with this prosperity comes an increase of responsibility as well as an increase of opportunity. And that next raises the question whether more consideration, more time, might not well be given to the matter of selecting officers. Now we know how it is done at present. Some time during the convention a committee is appointed, and they retire, and, with the best good-nature in the world, elect or suggest an excellent staff of officers, and the men elected have thus far very kindly agreed to serve, and have done nobly by the Association, as we all know. But it is getting to be a good deal of a tax on those who do serve. And it has occurred to me that perhaps a little more deliberate method might well be employed, and, as expressing my feeling in that direction, I will move, sir, that a committee be appointed, if possible before this meeting is dissolved, by the Chair, who shall investigate the matter between now and the annual meeting, and report at the annual meeting a list of officers for the Association. Now I know, sir, that according to all custom and precedent it is proper that the mover of a motion should be placed on the committee, and I therefore respectfully decline to serve on that committee, and ask you to make it up entirely without me.

The motion was seconded by Mr. Brackett.

The CHAIRMAN. — Gentlemen, you have heard the motion of Mr. Billings. Is there to be any discussion upon it? It seems to me as though there must be several here who will want to say something in regard to that; or else you are all so ready to endorse it that we will put it to a vote.

Mr. DARLING. — I will say that I can see no harm in that arrangement. I cannot see particularly how it will do any material good. At the same time, I do not believe there would be any harm in it, and I will second the motion for the purpose of seeing what will come of it.

On the suggestion of Mr. Darling, accepted by the mover, the number of the committee was made five.

The motion was unanimously carried.

The CHAIRMAN. — I will announce that committee later. You will now give your attention to a song by Mr. Danforth, called "The Silver Cup."

After the song by Mr. Danforth, the Chair appointed these gentlemen to serve on the committee: Frank E. Hall, Chairman; Edwin Darling, C. K. Walker, C. W. Morse, and George F. Chace.

Mr. F. L. Fuller then read a paper descriptive of a covered reservoir at Franklin, N.H.; Mr. John C. Haskell, one describing the foundation for the new Loretz pumping-engine at Lynn, Mass.; and Mr. Solon M. Allis, a paper describing the pipe system of Malden.

Adjourned, on motion of Mr. Walker.

TYPHOID FEVER IN ITS RELATION TO WATER-SUPPLIES.

BY

HIRAM F. MILLS, A.M., C.E., Member of State Board of Health of Massachusetts.

Typhoid fever is one of the diseases now generally attributed to one of the bacteria known as the typhoid bacillus. Bacteria are very minute vegetable growths, and this species is a rod with rounded ends, the diameter being about one thirty-thousandth of an inch, and the length about one ten-thousandth of an inch. When very highly magnified, fine, hair-like appendages, cilia, may be seen, extending from near either end.

It may not be unreasonable to think of the invisible kingdom of bacteria as consisting of as many species as the visible vegetable kingdom, and all of them doing as beneficent work in the economy of nature as the trees and plants which we see around us; but there is a small fraction, perhaps, comparable with the small number of poisonous plants, which are disease-producing.

The number actually known to produce disease does not exceed six, and among them is the typhoid bacillus.

It is not merely held that this germ is usually associated with typhoid fever, but that typhoid fever does not exist when this germ is not in the system — that it is the actual cause of the disease.

It becomes important, then, to determine how it can get into the system, and under what conditions it can live outside the human body.

These questions have been and are being studied with care, but there is much yet to be learned. That these germs may be taken into the body with the food and drink appears to be well established. There appears to be no good ground for believing that they live in the air, and are carried from place to place by winds; but it is not unreasonable to conclude that they may live in air long enough to be carried with dust on clothing from one sick-room to another, or from the sick-room to the kitchen, or be blown about a yard where slops from a sick-room have been thrown, or blown into the windows of a sleeping-room with the dust from a privy unfortunately near.

Cases, following one another in the same house, have been more readily explained by such communication than by the milk or drinking-water obtained from the same source as that used by neighbors who were not afflicted.

Milk is an excellent food for the typhoid bacillus, and if cans are washed with water from a well polluted by soakings from a privy where dejecta from a typhoid patient have been deposited, even the few bacilli that would remain attached to the can after the water had dripped out might, after milk was again put in the can, increase in a day to a dangerous number.

Many cases of prevailing typhoid fever in cities have been limited to a single milk route, and typhoid fever has been found to have been at the farm whence the milk was brought.

Drinking-water has many times been proven to be the medium by which typhoid fever has been communicated. I will pass by the marked cases which have been recorded in Europe, and limit observations to our own State.

In one of four mills in Canton where were employed one hundred and twenty men, about fifty were taken ill, in June, 1888, with symptoms of typhoid fever. One-third of the cases were fully developed typhoid fever, with one death. The other cases were abortive or of mild form. None of the women or children of the families of these men were taken ill. This limited the cause of the disease to the conditions at the mill, and excluded the conditions at their homes. The water principally used at the mill was from a well near by. This well was fifty-four feet distant from, and the water in it was about eight feet below the bottom of, a privy-vault at the office of the company, and a ledge rose up between.

Eight months previous to the attack of the men in the mill, a man at the office was taken ill with typhoid fever and used the privy there. There was, in the year, scarcely a case in town outside of these I have mentioned.

The questions arise, can germs of typhoid fever live in a privy, and in the ground, for a period of eight months? and was there any communication between the privy and the well?

The water of the well showed by chemical analysis that it contained about five times as much chlorine as pure ground-water in that region, and high nitrates, both of which indicated pollution from household wastes.

The ammonias were higher than those of unpolluted waters, but showed that the organic matter which the high chlorine and nitrates indicated was previously in the water had been pretty well filtered out.

To determine whether there was any direct connection between the privy-vault and the well, a bushel of common salt was put into the privy-vault. In one week the chlorine of the water of the well had increased fifty-three per cent., and in twelve days had nearly doubled, showing a definite connection through the ledge between the vault and the well.

The strongest proof we have that the germs of typhoid fever can live in a privy-vault, and in the ground, for eight months, and be slowly conveyed through the ground, where the conditions for filtration are such as to remove a very large part of the organic matter from the water, is in the result found here — that fifty men, every one of whom drank this water, were affected by this disease, and no other workmen in other mills around, where this water was not used, were affected. The proof here is not absolute, but the result is in line with other recorded cases where the time was shorter.

Our neighboring city, Newburyport, used well-water until 1881, when water was brought into the city from springs. In the nine years previous to the introduction of spring-water the number of deaths yearly by typhoid fever, per

10,000 inhabitants, was 4.55. In the seven years since the introduction of pure water the number of deaths per 10,000 has been only 2.07, or less than half as many as previously.

The highest death-rates by typhoid fever in the State are not in the cities, but are in the towns that depend for water upon wells. The five highest on the list, for the past eighteen years, have an average death-rate of 12.82 per year for each 10,000 inhabitants; while the five cities having the highest death-rate by typhoid fever in the past twelve years average 7.65 per 10,000, and the average for all of the cities of the State, in the same time, has been 4.62.

The town which had the highest death-rate from typhoid fever in the State was Ware, and in the fifteen years previous to 1886 the average number of deaths by typhoid fever in 10,000 inhabitants was 16.5. In 1886 this town introduced a supply of water, and in the years since, although the water has not yet come to be generally used, the number of deaths has fallen to 6.9, or four-tenths as many as previously.

Typhoid fever is properly regarded as a preventable disease, and before we close I think you will agree with me that our communities have responsibilities that cannot be ignored, in preventing the death of many people yearly scattered through all classes of society. That this is to a great extent a preventable disease is shown by these general facts: Twenty-five years ago the average number of deaths by typhoid fever in 10,000 inhabitants, in the places which are now cities in this State, was 7.8; the number now dying yearly from this disease in the same places is 4.6 in 10,000 inhabitants. In fact, the actual number of deaths from this disease twenty-five years ago in these places, when their population was only six-tenths as much as at present, was as great as it is now; and if measures for its prevention had not been taken, and the death-rate had continued as it was twenty-five years ago, we should now have 1,000 deaths yearly, when the actual number in the cities is 600.

With 600 deaths in a year in all the cities of the State, with a population of one million and one-third, we find our neighboring city of Lowell, with a population of 78,000, has in the last twelve months had 143 deaths from this disease — more than one-fifth of the whole number; and the city of Lawrence has had 66, or more than one-tenth of the whole number. These two cities have together had 68 more deaths by this disease in the past twelve months than the city of Boston. If these cities had had only as many deaths as the average of the cities, the number would have been 36 in Lowell, and in Lawrence 21. There have been in Lowell 107 more deaths, and in Lawrence 45 more deaths, from this disease in the past year than the average of the same number of inhabitants in the cities of the State. These are serious facts, and in considering the steps that should be taken to prevent the recurrence of such an affliction, the question of first importance is, whether the cause of this disease in these cities is exceptional or continues from year to year.

From the registration reports we find that for the twelve years from 1878 to 1889, the yearly average number of deaths from typhoid fever in all of the places in the State which are now cities has been 4.62 deaths for each 10,000 inhabitants.

The number of such deaths in each of the cities may be found in the following table: —

Average number of deaths in the cities of Massachusetts by typhoid fever, per year, for each 10,000 inhabitants, for the twelve years 1878 to 1889: —

Holyoke	8.93	Brockton	4.01
Lawrence	8.33	Lynn	3.87
Lowell	7.63	New Bedford	3.80
Chicopee	7.05	Newton	3.65
Fall River	6.32	Malden	3.54
Springfield	5.29	Worcester	3.33
Taunton	5.02	Newburyport	3.25
Haverhill	4.83	Cambridge	3.23
Quincy	4.68	Gloucester	3.23
Pittsfield	4.63	Fitchburg	3.16
Marlborough	4 59	Woburn	2.95
Salem	4.55	Somerville	2.95
Boston	4.32	Chelsea	2.89
Northampton	4.04	Waltham	2.42
All of the cities	4.62		

In this period of twelve years Lawrence stands next to the highest, with a yearly death-rate, from this cause, of 8.33 per 10,000, and Lowell follows next with 7.63.

There are four cities larger than Lawrence — viz., Boston, Worcester, Cambridge, and Lynn — whose yearly death-rate from typhoid fever averaged 3.91 per 10,000, or less than one-half that of Lawrence, and the death-rate from this disease in Lawrence was nearly double that of the average of the cities of the State.

The deaths of the past year are not included, in order that we may see the relative position Lawrence and Lowell have held with other cities in ordinary years.

Turning again to the tables, to see if the condition of Lawrence is improving or deteriorating, we find the following average death-rates from typhoid fever, per 10,000 living, for the four years 1886 to 1889: —

Lawrence	10.30	Haverhill	4.98
Lowell	9.55	Boston	4.05
Fall River	6.40	Cambridge	3.80
Holyoke	6.13	Worcester	3.11
Chicopee	6.06	Lynn	2.24

The average for all of the cities in these four years was 4.59.

Here we find Lawrence in these four years (next previous to and not including the last year), with the greatest death-rate from typhoid fever of any city in the State, amounting to 10.30 deaths yearly for each 10,000 inhabitants; followed closely by Lowell with 9.55; and then by Fall River with less than two-thirds as many.

Lawrence here has more than three times as many deaths by this disease, for the same number of inhabitants, as the average of the four larger cities of Boston, Cambridge, Worcester, and Lynn; and more than two times the average of the cities of the State.

It is to be noticed that the five cities having the highest death-rate from this disease are manufacturing cities, and there may be reason in attributing a part of the cause to the mode of life in such cities being poorly adapted to care in sickness; but on the other hand it may be seen by the last report of the State Board of Health, page 395, that the mortality rates of Lawrence, since it became a city, compare favorably with the mortality rates of the city population of the State, taken as a whole.

The diseases in which the death-rate of Lawrence especially exceeds that of other cities are typhoid fever and diarrhœal diseases, both of which are regarded as especially dependent upon the water used for drinking.

Comparing these manufacturing cities, we find there are twenty more deaths by typhoid fever each year in Lawrence than in the same number of inhabitants in Fall River; and in Lowell the condition is but little better than in Lawrence.

These two cities, Lowell and Lawrence, both well situated, well regulated, and comparing favorably for general healthfulness with other cities in the State, have fifty per cent. more deaths by typhoid fever, for the same population, than any other cities in the State.

These are the only two cities in the State which draw their water for drinking from a river into which, within twenty miles above, sewage is publicly discharged.

Within nine miles above the Lawrence water-works are the Lowell sewers; and within nine miles of the Lowell water-works is the State line, with the city of Nashua five miles beyond. Sewage from towns in Massachusetts on the Nashua river is freely turned into New Hampshire, and thence into the Merrimac river; and sewage from nearly one-half of the State of New Hampshire enters by the Merrimac river and flows through Massachusetts, past the cities of Lowell and Lawrence. Having no means of checking the entrance of the latter pollution was probably the controlling reason why the Commonwealth, in 1878, — six years after granting to the city of Lawrence the right to introduce its water for drinking, — by special statute, continued this river as a free receptacle for sewage.

The amount of sewage that has directly entered the river and its branches during the chemical examinations of the past three years is estimated to be about one gallon in six hundred gallons of the river water passing Lawrence, and there has been no more impurity in the water that could be detected by chemical analysis than in about one-half of the drinking-water supplies of the State obtained from ponds and streams; but the facts which have been presented showing that these two cities have so much higher death-rate from typhoid fever than any other cities of the State, together with what is known of the relation of typhoid fever to sewage-polluted drinking-water, are the strongest grounds for concluding that even with the small amount of organic impurity in the water, as shown by chemical analysis, the disease germs of this disease are able to pass, and do pass, from one city to the other in the water of this river.

This is conclusively confirmed by the following facts in the experience of the past year: In the early summer the deaths by typhoid fever in Lowell were about six per month, a little greater than the actual number in Boston, and about six times the number usual in the same population in cities, at that season

of the year. Lawrence was then having about the same number of deaths as other cities of its population.

In August, September, and October there were four cases of typhoid fever, about three miles up the river from the intake of the Lowell water-works, whose dejecta are known to have gone directly into the river.

In September the number of deaths in Lowell from this cause increased to eight, in October it was twelve, and in November it reached twenty-eight, when it was nearly twice the number in the whole city of Boston, and ten times the normal number for the population of Lowell.

This enormous increase in deaths followed about a month and a half after the typhoid dejecta were deposited in the river water, three miles above the intake of the Lowell water-works.

In August and September the number of deaths in Lawrence was two per month, bearing a normal relation to the deaths in Boston at that season. In October the number increased to six, and in November was five, or three times its normal number; and then began an enormous increase. In December the number of deaths was thirteen, and in January nineteen, averaging for the two months more than in the whole city of Boston, and nearly ten times the normal number for the population of Lawrence.

This great increase followed about a month and a half after the corresponding increase in Lowell.

After diligent search, no cause has been found which could have produced these results but that indicated by this recital of facts; and the conclusion that the deaths down the river were caused by the cases up the river, in the time which would be expected for such results to follow, is confirmed by the fact of finding in December the germ of typhoid fever in water from the service pipes of Lawrence.

That you may have definite knowledge of the relation of typhoid fever to drinking-water, I present the following experience of the cities of this State.

More than one-half of the cities of the State had public water-supplies introduced within the years from 1869 to 1877. In the table below are given the number of deaths from typhoid fever yearly in 10,000 inhabitants in each of the cities introducing water in the above period, for the ten years previous to the period and for the twelve years following it: —

Cities.	Yearly number of deaths by typhoid fever per 10,000 people, 1859 to 1868.	Date of introduction of water-supply.	Yearly number of deaths by typhoid fever per 10,000 people, 1878 to 1889.	Percentage deaths in the latter period are of those in the former.
Holyoke	6.73	1873	8.93	133
Lawrence	8.34	1875	8.33	100
Lowell	6.16	1872	7.63	124
Fall River	7.78	1874	6.32	81
Springfield	9.67	1875	5.29	55
Taunton	6.12	1876	5.02	82
Northampton	10.98	1871	4.04	37
Lynn	9.06	1871	3.87	43
New Bedford	7.77	1869	3.80	49
Newton	6.57	1876	3.65	56
Malden	8.04	1870	3.54	44
Fitchburg	10.59	1872	3.16	30
Woburn	8.29	1873	2.95	36
Somerville	4.28	1867	2.95	69
Chelsea	5.97	1867	2.89	48
Waltham	8.12	1873	2.42	30

Of these sixteen cities, all but three had less typhoid fever after introducing public water-supplies than before; and their average number of deaths from this cause was less than one-half of the number of deaths when they used water from wells.

The three exceptional cities are Holyoke, Lawrence, and Lowell, whose death-rate from typhoid fever in the above period, since the introduction of water, has not been less than previously.

Holyoke, though receiving water from an outside source for general use, has used, to some extent in the mills, water from the canals filtered through gravel beds in the bottom of the canal, or through some of the rapid filters used by paper-mills. No investigations have yet been made to learn whether the people using the canal water in this way are more afflicted with typhoid fever than others; and it is a fact that during the past five years, since the canal water has

been more carefully filtered than formerly, the death-rate in Holyoke from this disease, though still high, is lower than in previous years.

The continued high death-rate from this disease of Lawrence and Lowell, which, as before stated, has, in the four years previous to the last, put them far beyond all of the other cities of the State, must, in large measure, in the light of the experience of the other cities, be attributed to the polluted water-supply. And the experience of the others gives promise that, with a pure water-supply, the death-rate by this disease may be reduced by one-half.

DISCUSSION.

The CHAIRMAN. — Mr. Mills' paper is now open for discussion; or any of the gentlemen may ask him any question they see fit to in regard to it. If there is to be no discussion on this paper, I will call on Mr. Pratt to sing us the song that he sang at the last meeting, "The Drum Major," by request. (Great applause.)

Mr. HAWES. — I would like to ask Mr. Mills before he retires, to what extent he thinks typhoid fever is affected by gases arising from swamps where the water that is left in them has dried off, and where there is always more or less decayed vegetation. In Fall River we had a large extent of territory that was overflowed by the raising and holding back of water by the dam, and every summer that was dried off and exposed, and there was a great number of cases of typhoid fever in that region. A few years ago we had a law passed by the Legislature, that the reservoir company should keep that covered with water. Where they used to dry the water down to forty or fifty inches below high-water mark, they cannot dry it now to let waste water run below twenty-six inches; therefore keeping it covered. Then we had another case. One of our factories was built outside a little way, and they put several tenement-houses right into a swamp. They did not dig down much, but put them right on there with cemented cellars. In less than a year typhoid fever broke out; and one of the physicians told me there was more typhoid fever in those twelve or fifteen houses than in all the rest of the city. The question in my mind is, whether it was engendered by gases rising up through that cement from decayed vegetation. It could not be traced to the water, because they had the city supply of water. I would like to ask Mr. Mills' opinion on that.

Mr. MILLS. — It has been suggested that the germs of typhoid fever grow favorably in the ground after the settling away of the ground water, as in the case of draining a territory such as you speak of; and it has been thought that it prevailed more at times when the ground-water was lowest. At one time there was a good deal to confirm the idea that it depended very much upon that condition; but of late years the relation between the condition of the ground-water and typhoid fever has been very seriously questioned; and there has been but little proof brought forward that there is a definite connection of that kind. But it is probable there is some connection, and that the draining of a territory of that kind may be favorable to the growth of typhoid-fever germs; but they must get there from somewhere. They must get there, so far as is now known, from sewage which contains germs coming from people who had the typhoid fever. That is the present view of it by those who have studied it the most; but it is thought that condition is favorable to the growth of those in the ground,

and that there may be a communication for a short distance, such as the immediate surroundings of a house, but not a general communication through the air by winds, so that it would be communicated from one village to another by the wind blowing from one to the other. But they may be carried in the air only a short distance, to the immediate surroundings of a house.

Mr. HAWES. — Is there anything in the argument that I have heard used, that the majority of the typhoid fever in Boston originates on the lands that some years ago were filled in on the Back Bay?

Mr. MILLS. — I do not know whether that is true or not.

Mr. HAWES. — I know of a number of cases that have originated there recently — within a year or two.

Mr. MILLS. — Before the Back Bay was filled at all there was a very much larger percentage of typhoid fever than there is at present.

Mr. HAWES. — If I remember correctly, that was brought up in opposition to filling the Back Bay — that it would increase the typhoid fever.

Mr. MILLS. — This falling off in the number of cases to so great an extent is attributed to the introduction of good water, instead of using the well-water that was formerly used. I think that it has changed within a few years from something like 20 to 10,000 to something like 6 or 7, upon the introduction of water into Boston.

Mr. TIDD. — I would like to ask the gentleman one question in relation to that: whether, from any experiments he has made in filtration, he has become satisfied that any amount of filtration would restrict this?

Mr. MILLS. — Yes, sir; we have succeeded in filtering in the past few years at the rate of 300,000 gallons to an acre of water area, and we have concluded that no bacteria of any kind get through. We have not yet succeeded in filtering at a more rapid rate than 300,000 gallons to the acre a day. With the more rapid filtrations we have carried on, some bacteria have gone through. Whether typhoid bacilli will go through or not with this more rapid filtration we do not know yet, because we have just begun experimenting upon that particular bacillus.

Mr. TIDD. — I presume it is to be supposed they would go where any others would?

Mr. MILLS. — No, that is not to be supposed, for the reason that there are some bacteria that are adapted to just that condition of growth — that grow in the sand, that live in the sand; but the typhoid bacillus grows best at blood heat, and as we get down to lower temperatures it grows less vigorously.

Mr. TIDD. — So temperature has much to do with it?

Mr. MILLS. — Yes, sir; it has much to do with typhoid-fever bacteria, but it does not have the same relation to other bacteria that are adapted to the lower temperatures.

Mr. BILLINGS. — Mr. Mills' paper does not seem to have excited a very lively discussion; and I, for one, should be very sorry to have Mr. Mills leave the room with any impression that the amount of discussion measures in any way our appreciation of the value of the paper. I am sure that his paper has made a profound impression here. Facts and statistics such as these, presented as they have been, could not fail to have that effect. But there is not much opportunity for such a paper to be discussed, for its conclusions are unanswerable and stand

as they are, and they are of great value to us; and if the paper is published in full, as I hope it will be, in our Journal, I am confident that the number of our Journal that contains it will be a most noteworthy one.

Mr. ALLIS. — In some of the old reports that I have read I saw an account of an epidemic which broke out in New York some years ago. I think it was typhoid fever; I am not positive of that, but it was a fever, if I remember right; and it was a peculiar epidemic. A doctor took a map of New York and noted on that map, with red dots, every house where the fever broke out at that time. Afterward he took an old map of the city, which showed the drainage of the city before the city was filled up; and there was what had been a brick-kiln, which had dead water in it for many years previous, and which had been filled up with the various kinds of stuff with which they fill up such places in the city; and it appeared that in every single case where these red dots occurred it was right on that old filling. It occurred to me that was a very marked case. And I would like to ask if that fact has been brought into this study at all, as to whether these houses where fever occurred in Lawrence and Lowell have been built on filled land, as has been intimated in the case of Fall River. It strikes me that in many cases that thing might explain occurrences of this kind, although there is no question but that water is the largest cause, as has been so ably shown.

Mr. MILLS. — I will say, Mr. Chairman, in reply to that, that in Lawrence the cases that were reported in September, October, November, and December were plotted upon a map of the city. All the cases and the deaths were so plotted. The map was taken to the office of the water board to see if any cases were outside of the section supplied with water — beyond the water-pipes. There were three cases found to be beyond the water-pipes as they were plotted. An inquiry was made; that is, a messenger was sent to those houses, and it was found that they were numbered incorrectly in the directory, and that they must be moved down so as to be upon the water-pipes. There was not a case outside of the water-pipes. Then we have found that the number of bacteria decreases the farther we get from the reservoir; that is, across the city the water improves in the pipes, so that there is from ten to fifteen per cent. less impurity and better nitrification in the pipes on the opposite side of the city than at the reservoir, just as it comes out of the reservoir. The plotting of the cases of typhoid fever shows that some two-thirds of them were in that part of the city that was very much nearer the reservoir than the rest of the city; thus indicating that the typhoid-fever germs did not live in their full number to get across the city, but were more fatal and caused disease more in the neighborhood of the reservoir, and that the territory in which there was the greatest number of cases was not at all limited to low land which had been filled.

Mr. TIDD. — I would like to ask the gentleman whether the conclusion from that might be that it was the absence of light that affected them, or the gradual cooling of the water after it left the reservoir and got under the earth?

Mr. MILLS. — There was not much cooling of the water. At that season of the year — September, October, November, and December — there is very little change in the temperature, taking it right through the four months. There is some cooling in September; but we find, taking it right through the winter and all, there is a decided improvement in the water in going from the reservoir across the city; that there is from 10 to 15 per cent. less organic impurity.

Mr. TIDD. — In that case would you infer that the absence of light had anything to do with it?

Mr. MILLS. — I do not know that the absence of light really affects it so much as the conditions for nitrification. We find in our experiments in filtration that where nitrification is taking place, *i.e.*, where organic matter is being oxidized or burned up, the bacteria are also burned up. There is a decrease, for instance, in the filtration of sewage of about 5,000 bacteria to a thimbleful, day after day; and if that number, or quite a percentage of that number, can come through the filter before nitrification begins to take place, when nitrification does take place, and takes place completely, so as to burn up the organic matter, no bacteria come through. Thus it is directly dependent upon that chemical process of the burning up of the organic matter.

Mr. TIDD. — Then the nitrification does not depend at all upon the contact of the water with air?

Mr. MILLS. — Yes, it does. The water, as it goes into the pipes, has a considerable percentage of absorbed oxygen which is there and which is used in this nitrification.

Mr. TIDD. — Which is carried into the pipes with the water?

Mr. MILLS. — Carried into the pipes. The water absorbs oxygen from the air, not in combination, but as a mixture; and that oxygen is used in nitrification in the pipe.

Mr. TIDD. — From the air that comes in with the water?

Mr. MILLS. — Yes.

Mr. FULLER. — I would like to ask Mr. Mills if the sewage of Lowell was excluded from the river, whether the effect at Lawrence would be materially better — that is, whether there would be less typhoid fever than there is now? I suppose what affects Lowell is the sewage that comes in from above?

Mr. MILLS. — It is; and if none should get in at Lowell, more of the typhoid-fever germs would be killed in that nine miles than at present, so that it probably would be a benefit. But still we know that the condition of the water at Lowell is unfavorable, and there is no reason to think that in the single day longer that it takes water to go from Lowell to Lawrence they would be completely killed. There would probably be a less number, and less liability of trouble. But it would not be a prevention.

Mr. FITZGERALD. — You stated that the bacillus was not visible under a microscope of the highest power?

Mr. MILLS. — No, sir; I did not state that. I showed a picture of one which was seen by a microscope of high power, magnified 1100 times. I said that the differences between bacteria of different kinds, those that looked like the typhoid bacillus, could not be distinguished by a microscope of the highest power so that you could be sure of them. You can see differences, but you cannot be certain that one is the typhoid bacillus and the other is not.

Mr. HAWES. — I see that the people of the city of Lawrence have been ordered to take their germs of typhoid fever in a boiled state now, instead of raw. (Laughter.)

Mr. MILLS. — Yes.

Mr. HAWES. — Does the process of boiling kill the germs?

Mr. MILLS. — It does.

Mr. HAWES. — I did not know whether you had typhoid fever in a milder form, or whether it destroyed them. (Laughter.)

Mr. HASKELL. — I understood you to state that there was no case of typhoid fever in any part of the city of Lawrence outside of what was covered with the water-pipes?

Mr. MILLS. — Yes.

Mr. HASKELL. — In your opinion, if there had not been any water-pipes there, would there have been no case of typhoid fever during the year?

Mr. MILLS. — I have no reason to think that. As I said, the number of cases of typhoid fever in towns where they depended upon wells of polluted water was greater than in the cities with their water-supplies; and the average number in the five towns having the largest number of typhoid-fever deaths was very much larger than in the five cities having the largest number of deaths.

Mr. CHACE. — Is it safe, when the death-rates from typhoid fever in different cities approach each other somewhat closely, to decide that the health, so far as typhoid fever is concerned, can be safely compared between the two cities, basing it simply on the death-rate? Is it not possible that there is sometimes a greater proportion of cures in one case than in the other?

Mr. MILLS. — It may be that that may follow in some cases; but it is impossible to get at the number of cases of typhoid fever, because there are no reports of them. The physicians do not report half of them. In some cases they are very fully reported, and in others only partially reported; so we cannot depend upon the record of the cases, but we can depend upon the record of the deaths, and that is the nearest we can get to it.

Mr. CHACE. — I understood that point. I merely wanted to bring the attention of the Association to that fact.

The CHAIRMAN. — If there are no further questions and if there is to be no more discussion on this subject, the Secretary has some business that he will bring before the Association at this time.

Mr. STACEY. — I move that a vote of thanks of the Association be extended to Mr. Mills for the very interesting and valuable paper he has presented to the Association this afternoon.

The motion was unanimously carried.

DESCRIPTION OF COVERED RESERVOIR AT FRANKLIN, N.H.

BY

F. L. FULLER, C.E.

Mr. PRESIDENT AND GENTLEMEN: — When our President, Mr. Noyes, called upon volunteers to give some short papers or to say something, I thought that perhaps I might show you some blue-prints of a covered reservoir which I have made for the town of Franklin, New Hampshire. Two months ago, I think it was, we had an address upon storage water, and the speaker mentioned the benefit of covering reservoirs which were to contain spring or ground water. I think that we are all pretty well aware, from the results of the work of the State Board of Health, that this is an advantage, preventing

vegetable growths in the water; and I think there is also an advantage in having reservoirs covered because it keeps out the dirt, and leaves, and small vermin that are liable to get into an open reservoir. It is easy enough to cover a stand-pipe that is of small diameter, generally; but a common earth-reservoir it is rather difficult to cover, because the area is so large. The one that I have proposed for this town is built with a masonry wall and covered by brick arches. It is only a small one. The town is not very large and can pump continuously day and night, so that the amount stored is not required to be very large. This will hold about 484,000 gallons. It is 69 feet at the bottom, 71 feet across at the top, and the depth of water is 17 feet. There are two rows of piers from which are sprung supporting arches, which makes two rings, concentric rings which are 12 feet apart; and from the outside wall to these piers are sprung arches, two sets of them, and in the centre it is covered with an ordinary dump. The diameter of this dump would be 24 feet, and the distance of the covering arches, the span, would be 12 feet. The rise of the dump is 3 feet and 3 inches, and the rise of the covering arches is 1½ feet. The thickness of these arches is 8 inches. As you will see on the plan, this is covered with an earth filling which is graded off, and there will be some sort of a ventilator in the centre and a manhole at the side. The bottom slopes toward the centre, and the outlet and the inlet pipe is the same pipe. The cost of this reservoir, as I have figured it up, will be somewhere in the neighborhood of $8,000. There are about 700 cubic yards of rubble masonry, 143 yards of brick-work, 57 yards of concrete on the bottom, about 400 yards of cement, the finishing coat over this concrete bottom, about 440 yards of plaster, — coated on the side with Portland cement, — and perhaps about 3,000 yards of earth excavation. The pipe, as planned, was 10-inch; but it has been changed since the plans were made to 12-inch. So far, the price comes up to about $8,000, which, it seems to me, for a reservoir of moderate size, is not very extravagant.

DISCUSSION.

Mr. FitzGerald. — How much will it hold?

Mr. Fuller. — About 484,000 gallons.

Mr. FitzGerald. — That is about two cents a gallon?

Mr. Fuller. — I have not figured it up in that way.

Mr. FitzGerald. — This has not been built yet?

Mr. Fuller. — It has not been built. It may be well to say that probably in building this it will be necessary to allow the centering for the dump to remain in place while all the brick-work is done, and considerable of the other centering will be left in place. The roof should be put on so that there is a continuous line of brick-work straight across it. That is, the brick-work should be begun and carried on so that there would be a continuous line of brick built straight across it.

Mr. FitzGerald. — Is this outer ring made without the support of the earth?

Mr. Fuller. — It probably would not be. This wall would be built and the embankment put in place and thoroughly rammed before the brick covering was put on. The weight upon these piers is about 10 tons to a square foot. The piers are 12 inches square. There are 30 piers in all, — 20 in the outer ring and 10 in the inner ring.

Mr. FitzGerald. — I would like to ask Mr. Fuller if he made studies of other forms in comparison with this form?

Mr. Fuller. — Yes, sir; I made some computations. I found it would take considerably more material to store the same amount of water.

Mr. FitzGerald. — And the distribution of the arches was about the most economical one, as far as span, etc., are concerned?

Mr. Fuller. — It seemed to me so. I found it necessary not to have the piers too far apart, because, in building arches over them, if the distance apart was too great the arch overhung the line joining the centre of the piers.

Mr. FitzGerald. — Is the excavation in clay or gravel?

Mr. Fuller. — It is a clay hardpan.

Mr. FitzGerald. — These prices are estimated prices, I suppose?

Mr. Fuller. — Well, I call the rubble-stone work $5.50, the brick-work $15, the concrete $6.50, the excavation 75 cents. I have had one estimate that is a little less than that; and I presume when bids are made by contractors there will be found to be some variation.

Mr. FitzGerald. — What provision, on top of these arches, have you made for covering?

Mr. Fuller. — Do you mean the covering arches?

Mr. FitzGerald. — Yes, sir.

Mr. Fuller. — The arches are 8 inches thick, and will be covered by the material removed in the excavation.

Mr. FitzGerald. — I am glad to see these covers going on. I some time ago gave expression to that idea — that for all ground-water a covered reservoir is the proper thing. I have been doing all I can to get the same thing done in Brookline. I came very near it last year. I am very glad Mr. Fuller has taken this up and worked it out in this particular form. It strikes me as being very economical. Of course it might be a question of judgment in regard to the trusses being taken up partly by the earth. I suppose that they might be provided in this particular form with small buttresses, if thought necessary.

Mr. Hawes. — Have we not always thought that an open reservoir was better, where we had the air and light, than a covered reservoir?

Mr. FitzGerald. — Not for filtered water; and that is what ground-water practically is. I should like to ask if any one here can remember the price of the Newton reservoir and its capacity. It would be rather interesting to compare the two.

A Voice. — I think the capacity is 2,200,000 gallons, and the cost about $45,000.

Mr. FitzGerald. — Two cents per gallon. That would be just about the same.

DESCRIPTION OF AN ENGINE FOUNDATION AT LYNN, MASS.

BY

JOHN C. HASKELL, Superintendent Water Works.

Having had occasion during the month of May, 1890, to construct a foundation for the new Loretz duplex compound beam and fly-wheel pumping-engine of 10,000,000 gallons daily capacity, I will give a short description of the work.

The area occupied by the structure is 36 feet in length by 30 feet in width, having the Leavitt engine on one side and the wall of the pumping-station on the other; the pump-well at one end, while there was a space of 13 feet between the wall of the building at the other end. The foundation consists of 7 stone bearings set in brick masonry, the whole resting upon a bed of concrete 20 inches in thickness.

Three bearings are situated in the front, two under the centre columns, and two in the rear of the engine. It was necessary to excavate the earth to a depth of two feet below the bottom of the pump-well, 2 feet below the foundation of the Leavitt engine, and 5 feet below the wall of the pumping-station. The earth was gravel.

As our entire water-supply depended upon pumping by the Leavitt engine except about six days' supply from the reservoir when filled to its greatest capacity, it was not thought advisable to attempt to lay the entire foundation at once, but to take a portion at a time. Work was commenced upon a section 11 feet in width nearest to the Leavitt engine. When the excavation had reached to within 2½ feet of the desired depth, water was encountered. Upon reaching the required depth for the concrete, it was found that an area about 8 feet by 10 directly under the location of the central column of the Loretz engine was of an exceedingly loose character, and appeared to have been previously excavated and refilled. Upon sounding with a rod, hard bottom was felt at a depth of 7 feet. After removing the loose earth in this area, and while preparing to fill the excavation with concrete, the water burst in from the bottom, filling the excavation 4 feet higher than where it was first met. Upon sounding in the place where the water burst in, it was found that a fine sand extended 10 feet below without any indication of change in its character. Fearing that any attempt to pump the water while this fine sand underlying the gravel was unconfined might injure the foundation of the Leavitt engine by drawing the sand from beneath it, clear Portland cement was lowered in pails, until one foot in depth was spread over the bottom. After allowing the cement to set, the water was pumped out and the excavation filled to a height of 16 inches above the bottom of the concrete bed. After allowing 12 hours for the concrete to set, the remaining portion of the section was filled 12 inches in thickness, and all but a strip 2 feet in width, on the side nearest the second section, 20 inches in thickness. This strip was left to give a better bond between the two sections. After the concrete was placed in position, the water was allowed to rise to its full height before pumping was commenced with the Leavitt engine.

The remaining sections were laid in a similar manner.

The concrete was made with Portland cement, sand, and small stones, in the

ratio of 1—2—5 parts of each. Each layer was rammed thoroughly; the lower foot in 6-inch layers, the upper 8 inches in 4-inch layers.

The brick masonry was composed of hand-made, hard-burned bricks, laid in Portland-cement mortar, mixed in the proportion of 1 part of cement to 2 parts of sand.

No indications of weakness have yet appeared in any part of the structure.

PIPE SYSTEM OF MALDEN, MASS.

BY

SOLON M. ALLIS, Superintendent Water Works.

Having promised our President a five minutes' sketch of something pertaining to our water works, and having been very much pressed for time during the last month, I decided to bring you a topographical map of our city showing the system of pipes, hoping others may be led to do the same, as I, for one, can, in this graphic manner of showing a system, gain a much better idea of the difficulties different systems and circumstances present, and thus get a better knowledge of the manner these difficulties are overcome.

Malden has two supplies: one a gravity supply alternating with pump pressure from Spot Pond, 2½ miles away and 143 feet above our city; the other a supply drawn from 51 driven wells at about grade 10, the latter being an additional supply and in use but a little more than a year.

Our Spot Pond supply is brought down by a 12-inch pipe, and as the section supplied by gravity is now so large, the pressure (at City Hall), formerly 55 lbs., is reduced to about 48, by gravity alone.

This being inadequate for proper fire protection the pump at Spot Pond is run during the day, increasing the pressure to about 60 lbs.; and the night draft being less than the day, gravity gives us about 50 lbs. *while the pond is full.* When the water falls much below high-water mark, the pump has to be run night and day to keep up a suitable pressure.

This formerly had to supply the hills, which are quite plentiful with us, and the supply became very unsatisfactory. This has been largely remedied by our pump at Eaton's meadow, now called "Webster Park."

In connection with our new water-supply we have a stand-pipe on Waitt's Mount containing 1,158,000 gallons, the top of which is 235 feet above mean low tide. From this we have a pressure of about 100 lbs. at City Hall, or 105 lbs. at the lowest streets.

This is connected to the different portions of our system above grade 50 by special pipes laid for the purpose, but also large enough for estimated future demands, when those portions of the system below this grade (mostly old cement-lined pipe) are relaid with cast iron, and then connected with these main lines.

In addition to this we have a special "fire line," as it is called, being a 12-inch and 8-inch C. I. pipe connecting through Pleasant, Pearl, Charles, and Commercial streets with the hydrants opposite, and in the yards of our most

important manufacturing establishments, found mostly on the latter street, in the lower portion of the city.

Our expectation was, when putting this additional supply in working order, to use the stand-pipe pressure continuously on the fire line and those portions of the city above grade 50, calling that the high service, while those lower portions of the city supplied by gravity from Spot Pond are called the *low system*.

The weak pipes above grade 50 will be replaced the first thing in the spring, and we hope by June 1 to be able to use the stand-pipe continuously in connection with our high service. Then, as that service requires but about 600,000 gallons daily, we may dispense with continuous pumping at Webster Park, running that pump daily just enough to keep the stand-pipe full.

To use the stand-pipe pressure on the fire line at present, we have arranged to shut off the main line from the pump back of the fire-line connections, then open the gate below the stand-pipe, and at once increase the pressure on the fire main from 70 to 105 lbs.

This we have done in five minutes. Of course this will be obviated when once we get our system working as designed.

Now come some of the difficulties of such a system under present circumstances, by cutting off our circulation in so many places, by arbitrarily entering the old pipes at grade 50, and shutting off everything below.

We make many dead ends, which must be blown off occasionally, and care must be used to prevent the high pressure by accident getting into the low system, for that means a "*burst*" immediately.

Then again when, for any reason, the pump at Webster Park must be stopped temporarily, we must at once reconnect the two systems, and let Spot Pond pump do the best it can to again take care of the hills while the other pump is not running.

As our trunk lines make several sharp angles and many of our connecting pipes are but four inches diameter, the pressure varies greatly; and when these changes occur, some one goes without water for a while. This we generally hear about at the office, with a vigorous remonstrance not always unexpected.

Again, I would advise all who contemplate having two different water-supplies to get them as near alike as possible. Spot Pond water is very good and soft, though sometimes affected with the usual summer complaint of all ponds not properly cared for; while Eaton's meadow water is very hard, though cool, clear, sparkling, and good-tasting water the year round.

Some of the citizens who are obliged to use Eaton's wells water, from living in the locality thus supplied, protest because it is *hard*, and sigh for that of Spot Pond; while others who are on the Spot Pond system are not happy, because they want the Eaton's wells water. Between them both the Superintendent and Water Board sometimes think of the old saying of the young man sitting between two girls, who said, "How happy I'd be with either, were t'other dear charmer away."

Time, however, adjusts all things, and most of our citizens are very well contented with the quality of the supplies furnished, and, especially if any go to the West, when they come home congratulate themselves on the difference being so much in their favor.

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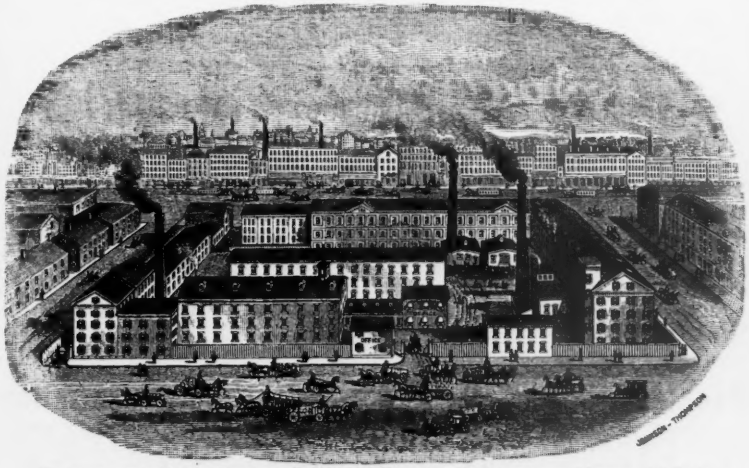

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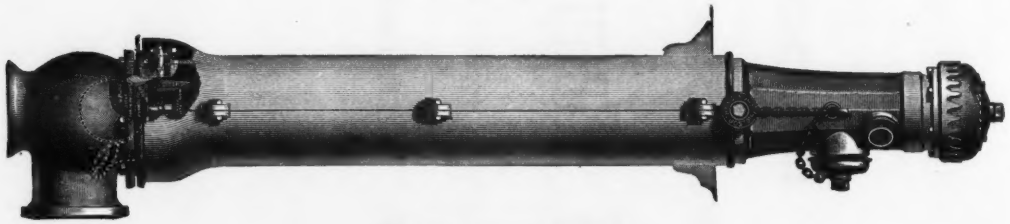

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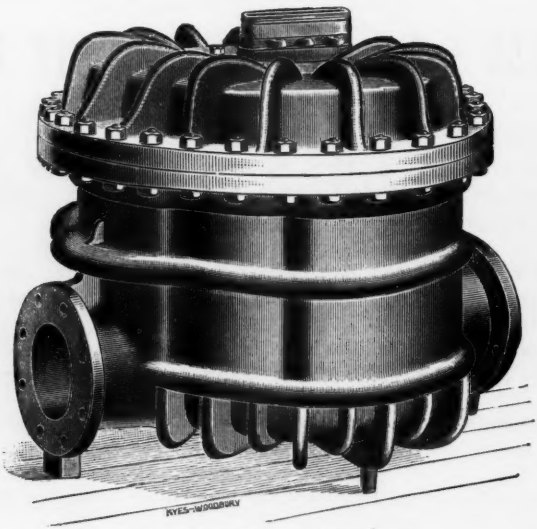

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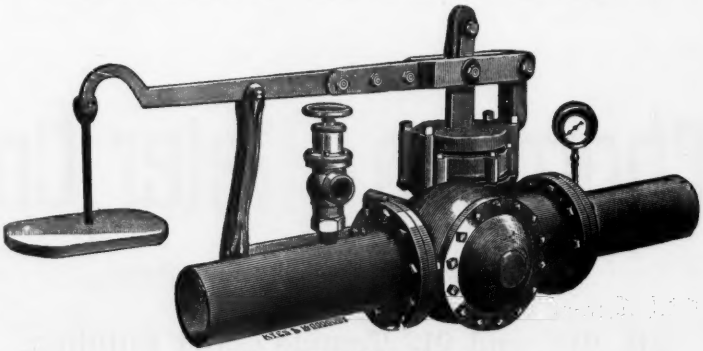

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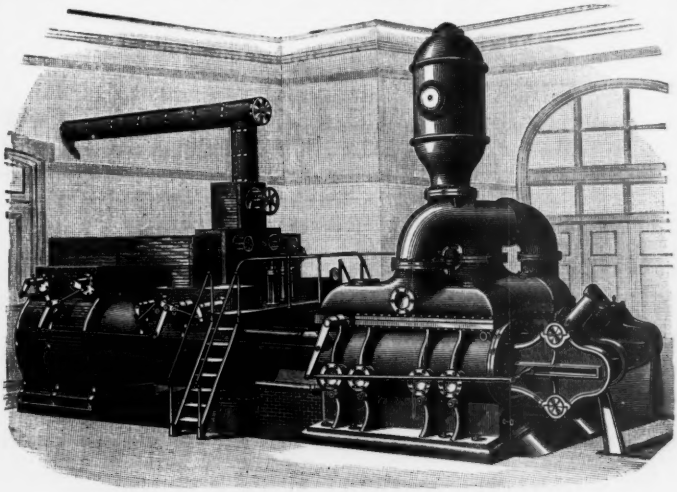

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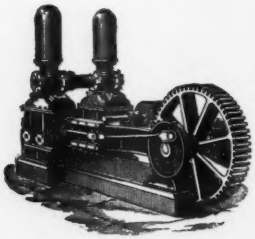

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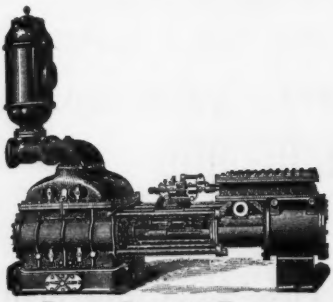

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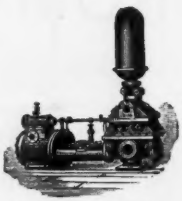

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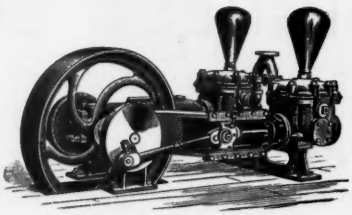

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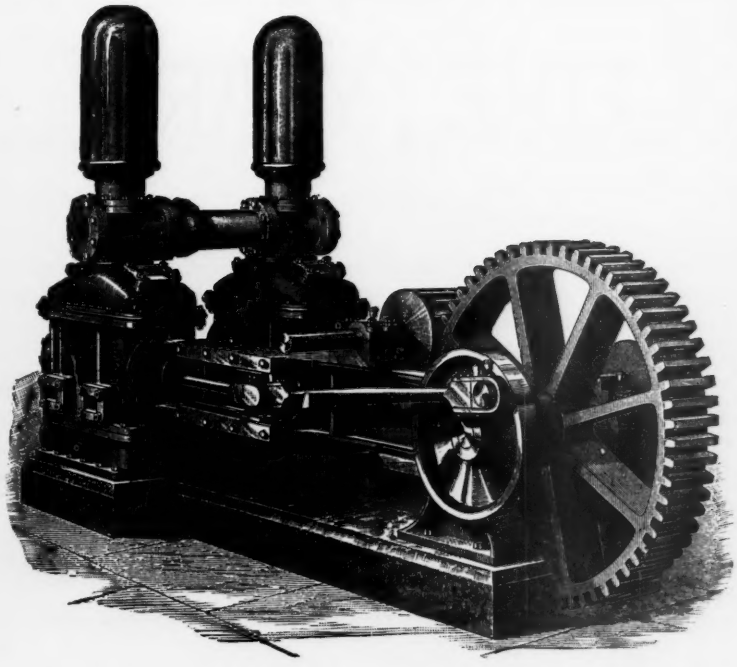

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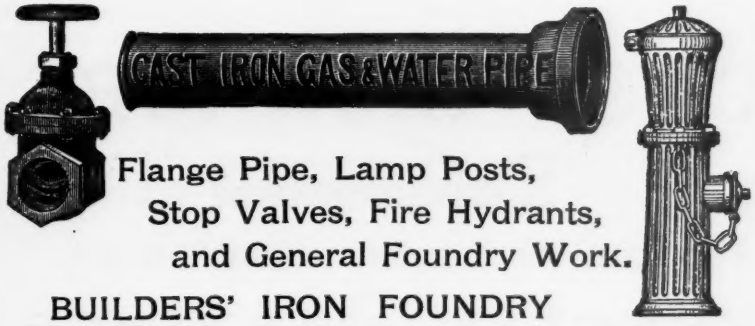

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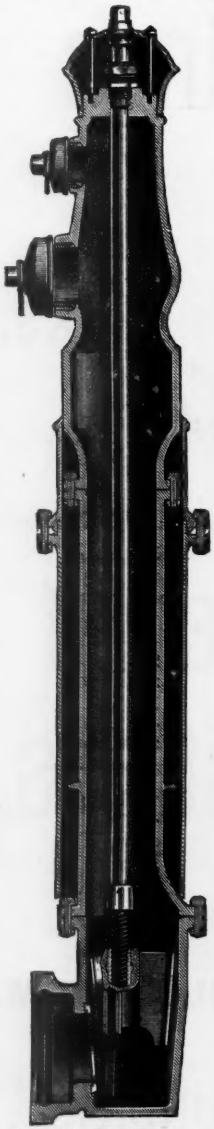

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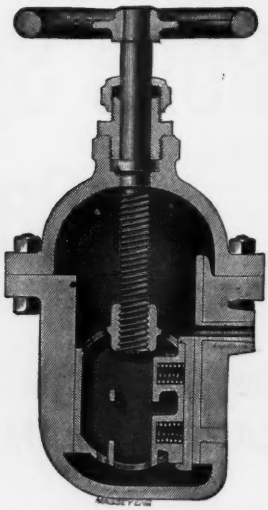

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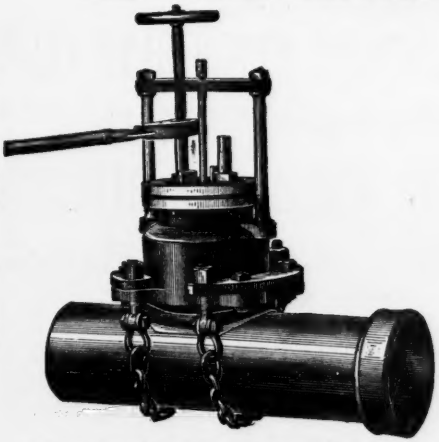

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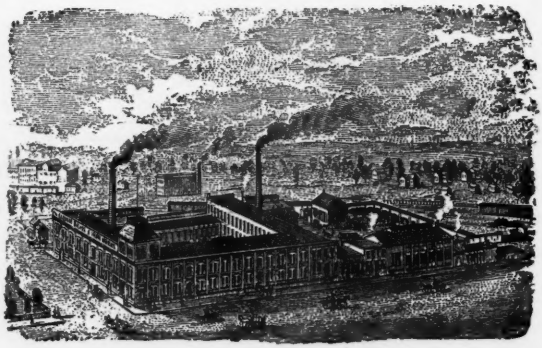

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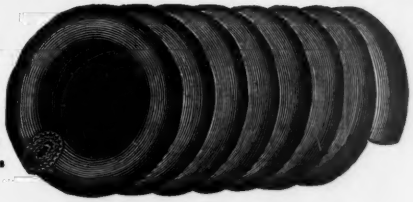

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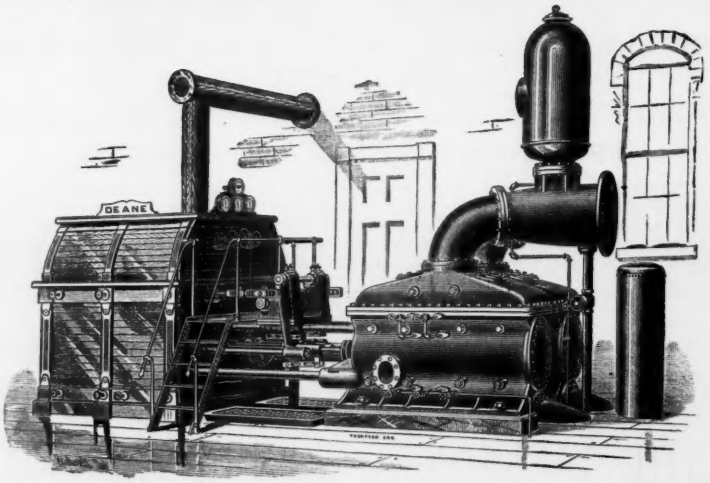

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The New England Water Works Association

was organized in Boston, Mass., on June 21st, 1882, with the object of providing its members with means for social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only twenty-seven, its growth has prospered until it now includes the names of more than 400 men. Its membership is divided into two principal classes, viz., Active and Associate. The active membership is further divided into two classes, viz., Resident and Non-resident, — the former comprising those residing within the limits of New England, while the latter class include those residing elsewhere. The initiation fee for the former class is five dollars; for the latter, three dollars. The annual dues for both classes of Active membership is two dollars. The Associate membership is open to firms or agents of firms engaged in dealing in water-works supplies. The initiation fee for Associate membership is ten dollars, and the annual dues ten dollars. This Association has four regular meetings each year, also a series of informal monthly meetings, during the winter months, at Boston, Mass.

The Journal of the New England Water Works Association

is a quarterly publication, containing the papers read at the meetings, together with verbatim reports of the discussion. It also contains interesting contributions from writers of the highest standing in their profession. It affords a convenient medium for the interchange of information and experience between its members, who are so widely separated as to find frequent meetings an impossibility. Its success has more than met the expectation of its projectors; there is a large and increasing demand for its issues, and every addition to its subscription list is a material aid in extending its field of usefulness. All members of the Association receive the Journal in return for their annual dues; to all others the subscription is two dollars per annum. If upon inspection of the accompanying copy you feel so inclined, we should be glad to receive your subscription.

The Secretary would be pleased to give further information to any one desiring the same. Address,

R. C. P. COGGESHALL,
Secretary New England Water Works Association,
New Bedford, Mass.